What Got Us Here, Won't Get Us There

15th International Conference of the European Academy of Design

ONLINE and in **PERSON** in **Brazil**, **Finland**, **India**, **Spain** and the **UK**.

16-20 October 2023

Interactive Design as Mediation for Social Connection Against Loneliness of Vulnerable People

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Abstract: With social improvement, the emotional connection problems faced by vulnerable people have got the attention of society. This paper explores how design can establish social connection as a form of mediation. To achieve this goal, we conducted a review of relevant literature and in-depth interviews with 21 individuals considered vulnerable. We then conducted several case studies from the Industrial Design department of TU/e, providing an overview of the forms and features of interactive design in this context. Through this exploration, we identified five essential elements of emotional connectedness design: role, relationship, engagement, trigger, and expectation. Design guidelines were proposed according to the five elements. We also present an ideation process for designing social connections. We discuss the rationality of our design method and establish it as a guide and evaluation tool for the design process. Finally, we discuss future research directions and conclude our findings.

Keywords: Vulnerable people, Interactive design, Mediation, Social connection, Loneliness

1. Introduction

1.1 Vulnerable People and Social Connectedness

The societal acceptance of networking technology has rapidly advanced, resulting in improved social involvement and the opening up of new communication channels for vulnerable individuals (Severo, et al., 2021). As societies become civilized and economies are reinforced, there is a natural inclination to pay more attention to the needs of vulnerable populations (Brooke & Jackson, 2020). Consequently, people have begun using new media tools to express themselves and propagate ideas (Wang, McKee, Torbica, & Stuckler, 2019). The innovations in digital media have significantly improved the simplicity and speed of communication and a wide array of visual experiences. Physical or mental impairments may limit some vulnerable individuals' access to information, but many still desire relevant social information to enrich their emotional well-being (Cheng, et al., 2020). However,

information professionals typically need a comprehensive understanding of the unique requirements of vulnerable people, which hinders the creation of user-centered designs. It is, therefore, critical to incorporate various interactive multimedia designs to provide information on multiple levels, ensuring that it is accessible to all.

The challenge lies in addressing the psychological difficulties experienced by vulnerable populations. Social support is a recognized factor influencing their mental health, which depends on their level of social connectedness (Harandi, Taghinasab, & Nayeri, 2017). Social connectedness is an individual's subjective psychological bond and sense of belonging with others and groups (Hare-Duke, et al., 2019). Social relationships, or social ties, are crucial for individuals to feel connected to others and influence their health and well-being (Barbosa, et al., 2019). However, many vulnerable people experience social isolation, which impedes their physical and mental health (Hwang, et al., 2019). Vulnerable populations may face significant obstacles due to negative attitudes and portrayals, leading to poor self-perception, helplessness, and dissatisfaction (Rogers, et al., 2020). Conversely, positive attitudes enhance social connectedness for these individuals.

1.2 Design Response to Social Connectedness

Many researchers have relied on literature reviews, interviews, and focus group discussions to ascertain the needs of specific populations. However, advances in interactive technology now offer novel avenues for enhancing the social connectedness of vulnerable groups. Modern interactive media technology enables designers to perceive and experience their creations in new ways, yielding numerous benefits for design quality and efficiency (Dixon, 2015). Responsive settings and objects can be developed using various monitoring techniques, including sensors, commonly utilized by new media designers and artists working on interactive installations. The concept of "body-sensor co-performance" underscores the performative nature of interactive art and the real fusion of technology and the human body (Tikka, 2021, p. 84).

Many studies have focused on designing technology to provide functional solutions for vulnerable individuals. This can be particularly beneficial when immediate assistance is unavailable, as it prioritizes their physical safety. However, many of these studies have overlooked the psychological well-being of vulnerable individuals. In order to enhance the social connectedness of vulnerable individuals with the general public, Weiser proposed that the most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it (Weiser, 1999). Despite numerous studies investigating the connectedness between vulnerable individuals and the general public, much work still needs to be done. Many design solutions present information in a limited and rigid manner that is often simplistic, direct, and abrupt. This falls short of seamlessly integrating into people's daily lives and ideally, being aesthetically pleasing.

1.3 Design as Mediation

Marshall McLuhan argued in his book Understanding Media that "The medium is the message," emphasizing the importance of both media and design in advancing individuals and society (McLuhan, 2012, p.54). According to Neil Postman, one of McLuhan's students, "media is a metaphor," implying that media is much more than the information it conveys; instead, it reflects people and constantly reshapes their sensory perceptions daily (Hoskins, 2011, p.138). From a media environmentalism perspective, design has always adhered to the core principle of being "people-oriented" since its inception. Whether it is barrier-free design to promote social ethics, interactive design for future advancements, or sustainable design for the environment, the ultimate goal is to enhance people's

quality of life, with people and society serving as its primary focus and guiding concept. "People" serve as the vital link between media and design. On the one hand, media profoundly impacts "people" and the social structures in which they exist. On the other hand, design can further influence "people" by making corresponding adjustments based on their changing needs and preferences. The ultimate manifestation of a design is also regarded as a form of media, and its format should be adjusted accordingly. From this perspective, media and design are closely intertwined. As media forms evolve, the relationship between design and media becomes increasingly complex, and design methodologies are progressively adapted to keep pace.

This study broadens the scope of inquiry to include all categories of vulnerable groups and explored their shared characteristics. The current knowledge and techniques for using interactive design as a mediator to facilitate social and emotional connections for vulnerable groups still need to be more mature. In order to demonstrate practical knowledge, this study aims to provide a solution to how design can mediate social connections to reduce loneliness among vulnerable individuals. According to the practical social design theory, design should bring people together to tackle issues rather than collectively isolate individuals (De Lange, & De Waal, 2017). Currently, evidence-based research has become a popular approach to interaction design. This study gathered experience by examining design cases from the Industrial Design department of TU/e. We introduced a new interactive channel for vulnerable people through design, criticized passive interactions, and advocated active participation to increase social vitality through innovation.

2. Method

We utilized two methodologies to address the issue of social isolation among vulnerable populations. One methodology employed was the curation and synthesis of the design cases from recent years within the Industrial Design department at Eindhoven University of Technology (TU/e) in the Netherlands. This approach targeted the forms or elements of interaction design catering to vulnerable populations. Through a comparative and analytical lens, this method aimed to elucidate the critical aspects of successful design strategies for addressing social isolation among vulnerable populations. The second approach emphasized the design process as a conceptual and ideational process, seeking to explore how designers generate innovative ideas and solutions — and subsequently applied to the design process of subsequent stages. Artifacts were categorized according to their stages of development, ranging from conceptualization to prototyping to finished products. Furthermore, design knowledge was generated through reflection on the design process.

We conducted an eight-week study to alleviate social exclusion and loneliness among vulnerable populations. The study employed the design thinking method, which involved five stages: empathize, define, ideate, prototype, and test. During the empathize phase, user interviews were conducted with 21 disabled citizens from the Netherlands to gain insight into their experiences with social exclusion and loneliness. Due to space constraints, this article does not include the questionnaire used during the interview. Participants were questioned about their strategies for coping with emotional isolation and their communication methods, social interactions, emotional issues, and social difficulties. The insights obtained from the user interviews served as valuable inputs for the ideation process of the design. Moreover, it assisted the study in identifying that social interaction required mediation. For instance, a middle-aged male participant stated, "Loneliness for me equates to a lack of popularity among people, which results in my reluctance to engage in social activities." This statement prompted us to consider the significance of "unconscious engagement" throughout the optimization design process. As a result, a range of cases was gathered and analyzed to stimulate creative ideation. Table 1 presents the compiled cases from the Industrial Design department of TU/e and provides examples of coping mechanisms employed by vulnerable individuals to manage loneliness.

Table 1. Cases from the Industrial Design department of TU/e to show how to enhance social connectedness

Cases	Brief introduction	Methods to enhance social connectedness
Read2Share System (Kang, et al., 2022)	Using interactive public display systems to catalyze and facilitate social interaction among nursing home residents	-peer-to-peer interaction -productive activities
Brick-Through (Kang, et al., 2018)	The Brick-Through design enhances the connections between residents in a nursing home and citizens from local communities	-anonymous interaction -richer possibilities
Closer to Nature (Feng, et al., 2018)	The plaster goat design offers residents in wheelchairs a more inviting interaction through more effortless motor action.	-initiating interaction -multi-sensory engagement
Dynamorph (Feng, et al., 2018)	A four-layer interaction design with a Montessori method for senior residents with dementia at different stages in Long-Term Care Facilities	-leveled stimulations -meaningful engagement
Social Glasses (Qiu et al., 2019)	Social glasses with an eye-tracking system enable eye-to-eye contact between blind and sighted people, allowing for greater conversational engagement.	-assisted communication -technology-enabled natural connection
Story2Share (Li, et al., 2019)	Story2Share was created to encourage storytelling between older adults and their offspring.	-cross-generation inheritance and innovation -emotional expectation

This paper engaged in discussions and generated several proposals, encompassing various design methods such as interactive experience and art form design. The discussion output was documented as the raw material for analysis in this stage. We could better understand the users and develop user knowledge by analyzing the user research data collected in the empathize phase. Analyzing the methodology used in this paper and the documented cases (materials developed during the ideate and prototype stages) helps the organization determine the design outcomes. Knowledge of the ideation activities is produced through reflection on the ideation process (materials produced in the ideate phase)

The card sorting approach was used to dissect and group the design components. To more intuitively demonstrate the implementation potential of these design strategies, Table 1 listed various instances of creative design practices relevant to design elements. For instance, the element of 'peer-to-peer interaction' was extracted from the case of the Read2Share System, and a similar function was used in each case to group those items into one category. Each design concept was explored in detail, and the categories of emotional design elements were theorized by comparing them to ideas from other areas.

3 Results

The findings section will provide the five design elements, related methods, and the ideation process connected to the five design elements. Our proposal will also show how the design combines these five elements.

3.1 Five Elements and the Strategies

Role - Untapped Desire for Generativity. The first element is the generative role. The emphasis on the generative role allows vulnerable populations to explore a new world, regardless of their limitations. One of the potential impediments to achieving social equality for vulnerable populations is the presence of negative attitudes toward them. Research has found that viewing vulnerable populations as a drain on society requires a significant investment of resources, making designing practical methods complicated (Giles-Corti, et al., 2016). A generative role is critical for encouraging vulnerable people to feel fulfilled and can enhance their emotional well-being. Utilizing the productive potential of disabled individuals, for example, could benefit society. Empirical studies have shown a correlation between generative participation and the health of vulnerable populations such as the disabled and elderly (McAdams, & Guo, 2015). Therefore, interactive multimedia design for vulnerable individuals should reflect solid humanistic values, promoting their integration into social groups and enhancing their sense of connection. The design of Social glasses(Qiu et al., 2019) with an eye-tracking system enables eye-to-eye contact between blind and sighted people, allowing for greater conversational engagement on both ends (Figure 1). Social glasses serves as a medium to facilitate the engagement of visually impaired users in contributing to society. Due to visual impairments, some individuals cannot participate in personalized activities, leading to social isolation. The design of these glasses has initiated increasingly complex interactions, amplifying the reward effects and social connections and promoting positive social behavior. This project provides visually impaired users opportunities to enhance their self-esteem and recognize their societal value while delivering critical social services.
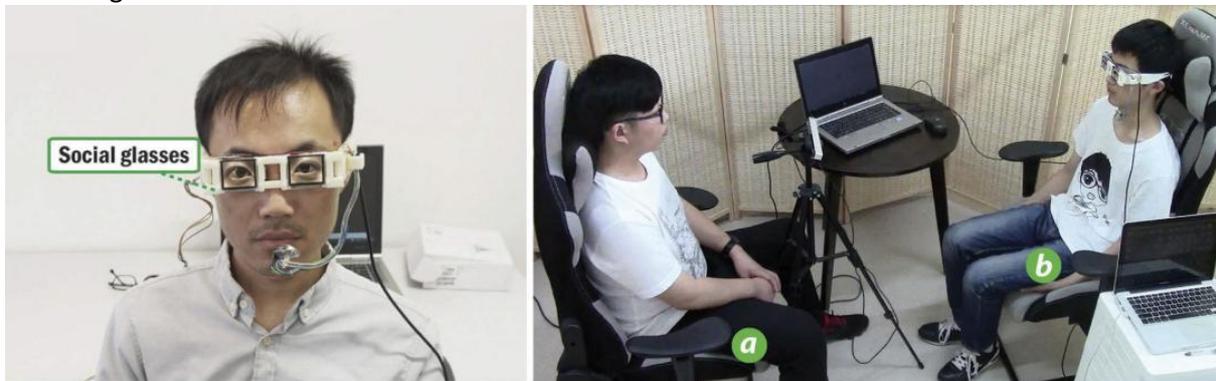
Figure 1. Social glasses by Qiu et al. (2019).

Relationship - Social Effectiveness of Weak Ties. According to Granovetter, the reciprocal partnership is the second element in strengthening human society's connectivity by understanding the rationality behind strong ties and weak ties (Granovetter, 1973). While personal connections have traditionally focused on strong ties, such as close friendships, marital connections, and parental bonds, weak ties are also prevalent in people's lives. They can contribute to happiness while potentially developing into strong ties over time. Strong ties typically involve frequent interactions and create repetitive information that can form a closed system. In contrast, weak ties exist between groups and are more widely distributed as a bridge for information and resources across social barriers. They can provide valuable information to individuals not belonging to these groups. This article suggests that interactive art can be crucial in transforming weak ties into strong ties, particularly for vulnerable individuals, by increasing their social connections. For example, Kang et al. (Kang, et al., 2022) conducted a study on the potential of using public display systems to facilitate unplanned social interactions among residents(Figure 2). They developed a desktop display system

called "Read to Share" (R2S) to enhance the reading experience and social interaction of elderly residents in a nursing home. The findings demonstrated that R2S facilitated participants' engagement in viewing and sharing content, effectively promoting social interaction among strangers. The individuals gather in the exact location and share a common passion for reading, allowing them to establish strong connections through shared experiences and conversations.

Figure 2. Read to Share by Kang et al. (2022).

Engagement-From Intentional to Unconscious. Drawing from earlier research on human behavior, the theory of unconscious interaction and cognition has proven to be a valuable tool for designers in crafting innovative interaction concepts (Badke-Schaub, & Eris, 2014). By integrating the study of unconscious behavior into interaction design, the field of interaction design can expand its research scope from the perspective of psychology and behavioral science. This approach can lead to new concepts and methods for creating user experiences and directions for developing interaction design. Interviews with vulnerable individuals have indicated that they may be hesitant to seek out friendships out of fear of being perceived as lonely and unpopular. As a result, social interaction may require mediation. In such cases, interactive multimedia design can serve as a bridge to facilitate social connections for vulnerable individuals and effectively address feelings of loneliness. For example, the Closer to Nature(CtN) (Feng, et al., 2018) device provides calm, enjoyment, and happiness for elderly dementia patients by simulating natural elements and offering rich sensory stimulation(Figure 3). The device successfully evokes memories in dementia patients by using a farm landscape and an old-fashioned water pump. The design of CtN is also considered a valuable tool for facilitating emotional communication among residents and family members, between residents and caregivers, and among residents themselves.

Figure 3. Closer to Nature by Feng et al. (2018).

Trigger-the Stimulation of Active Responses. According to the results of a user survey conducted for this initiative, many vulnerable individuals express an interest in making new friendships. However, forming comfortable relationships can be challenging, and social events are often held in public places with a roll-call strategy to ensure everyone participates in communication. This rigid approach to the conversation makes it difficult for long-term and deep emotional connections to form, and

people may feel uncomfortable or refuse to participate. Professor Fogg's behavior model suggests that human behavior is determined by motivation, ability, and trigger, and an appropriate trigger can spark dynamic conversation and social connections (Fogg, 2009). Therefore, interactive art can serve as a trigger to facilitate natural and spontaneous conversation, supporting the development of meaningful relationships. For example, Story2Share(Li, et al., 2019) consists of a slots-machine-like device used by elderly individuals and a mobile application used by their children(Figure 4). It aims to facilitate intergenerational storytelling about memories. The young generation has the option to capture photographs of family memorabilia, and the contents of old photographs can naturally and effortlessly trigger elderly individuals' memories, allowing them to recount their stories to their children through the device. Empirical research has demonstrated that using old photos to trigger memories results in a comfortable and relaxed environment for the elderly. It enhances emotional communication between the elderly and the younger generation.
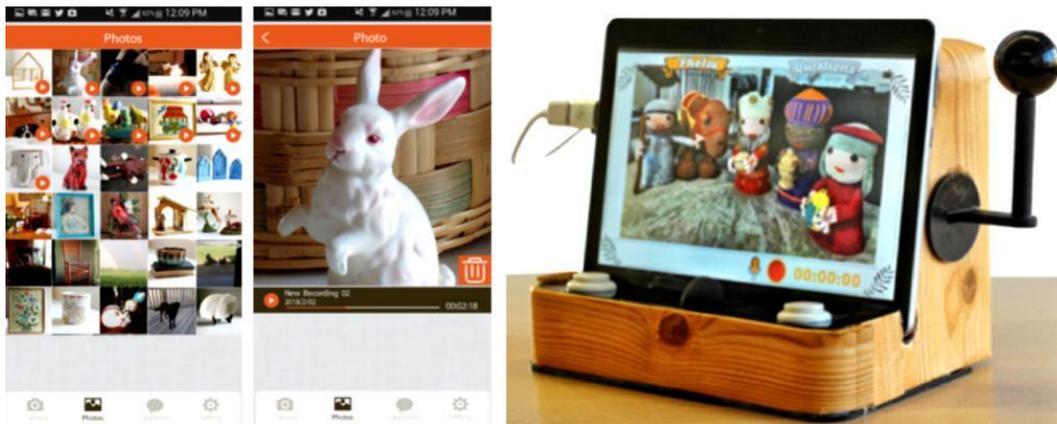

Figure 4. Story2Share by Li et al. (2019).

Expectation-From Physical to Emotional. Physical interaction and emotional connection are two important ways social ties are expressed. From an interaction standpoint, physical interaction provides space for physical encounters and ease of access, while emotional connection involves similarities and intimacy. Donald A. Norman proposed three levels of emotional design: visceral, behavioral, and reflective (Norman, 2003). This study investigates the application of emotional factors in design to provide users with a positive emotional experience that reflects the identity of vulnerable individuals through personalized proximity. In order to achieve an optimal balance of people, art, and emotion, emotional factors must be incorporated into the design. Currently, many interaction design cases have shown that the emotions of vulnerable individuals can be visualized during physical interaction, making the interaction more relaxed and pleasant and enabling communication and empathy between individuals. However, to achieve a more profound emotional experience, it is essential to consider how to stimulate interaction expectations through design to establish deeper emotional connections. For example, the implementation of Brick-through(Kang, et al., 2018) had a beneficial impact on social interaction among elderly residents living in a nursing home(Figure 5). Through this device, elderly residents can view scenic photographs shared by citizens, which can then be printed as postcards and sent back to the citizens. In addition, the device facilitates conversations when used together. It is designed to use the metaphor of "looking outward" and "sending postcards" to deepen emotional connections between nursing home residents and the broader community through sharing and anticipation.

Figure 5. Brick-through by Kang et al. (2018).

3.2 Framing the Ideation Process

The five elements presented in Figure 6 work together throughout the ideation process to establish social connections. The first stage involves envisioning a positive role for vulnerable individuals in society. Despite being vulnerable, they can make meaningful social contributions. By aligning their personal choices and practices with social requirements, vulnerable individuals can better integrate into society and develop a sense of purpose. Subsequently, social relationships can be established by connecting public and emotional demands. For instance, people with disabilities may deeply understand a city's history, while visitors may be interested in learning about its historical memory. Relationships can be formed by connecting story resources with the requirement to comprehend the tale. This stage acts as a bridge between personal and societal connections. To establish a relationship, engagement is crucial. Once an engagement is established, the designer must consider how to stimulate interaction through triggers naturally. People generate emotions and expectations during natural interaction, forming lasting emotional interactions. Lasting emotional interactions help vulnerable groups transform weak ties into strong ties. This ideation approach ensures the design is grounded in strategic planning and carried through to the design details.
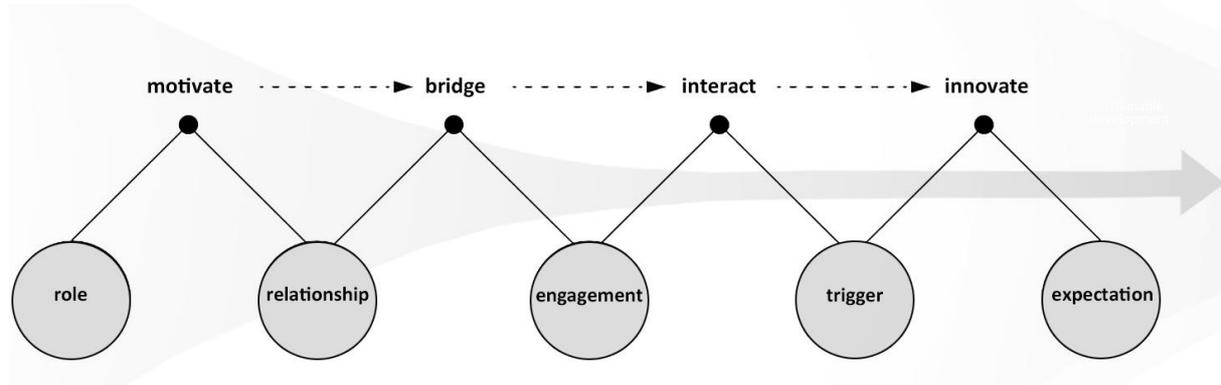

Figure 6. An ideation process of design for social connection

4. Discussion

4.1 Design Strategy to Guide Design Process and Evaluate Design Quality

Vulnerable groups tend to form strong ties with their relatives while maintaining weak ties with their peripheral social circles. During our interviews, vulnerable groups mentioned their lack of interest in collective activities. However, according to feedback from caregivers, they indeed experience greater happiness when participating in group activities. This also confirms that developing weak ties can

enrich their emotional lives. Therefore, establishing connections through design as mediation has essential research value. The above case studies have confirmed the indispensable role of the five design elements in establishing social connections and their interrelationships. For instance, in the "Brick-Through" case, users initially showed great enthusiasm to participate. However, the lack of consideration for the "expectation" element in the design led to a gradual decline in user engagement in the later stage. As a result, further improvement and innovation are needed in the design of the "emotional expectation" aspect to sustain the users' engagement and expectations. The five essential design elements have been integrated into a coherent conceptual process, focusing on the vulnerable populations' active participation in interactive design. The design strategies derived from this study can guide the design process and evaluate design quality.

4.2 Promote Sustainable Interactive Systems by Fully Utilizing the Roles of Stakeholders

As it is challenging for vulnerable groups to establish long-term emotional connections with their peripheral social circles, this paper highlights the importance of sustainable design in interactive systems. The case study presented in this paper, "Story2Share," focuses on two aspects of emotional sustainability in interactive systems. Firstly, it promotes sustainable emotional interaction across generations by facilitating the exchange of stories between the elderly and children, establishing an emotional "bridge" for developing meaningful "relationships." Secondly, including "expectation" elements in the design ensures the sustainable generation of innovative content, promoting the durability of interactive novelty and freshness. However, the paper notes a drawback in neglecting the "role" element in the early design, leading to technical difficulties for some elderly users and psychological frustration. This highlights the interdependent nature of the five design elements. Thus, the later design includes barrier-free technical support for vulnerable groups, stimulating group innovation and interaction and creating imaginative space for participants while fostering deep emotional connections. It is important to note that the design of interactive experiences for vulnerable groups should consider all users and stakeholders, including family members, caregivers, and volunteers, as they are involved in and influence one another. This approach is valuable for promoting sustainable interactions through design as mediation.

5. Conclusions and Future Work

As contemporary society has progressed, the issue of social isolation among vulnerable individuals has garnered increased attention. This study explores how design can serve as a mediator to foster social connectedness and tackle this problem from a design perspective. Drawing on a review of design methodologies, this research outlines five design elements that can help link isolated, vulnerable individuals with others: generative roles, the social efficacy of weak ties, unconscious engagement, the stimulation of active responses, and emotional expectations.

This paper delves into using design as mediation to promote social connectedness and outlines four ways design can facilitate this: motivate, bridge, interact, and innovate empowerment. Examining the five design elements of role, relationship, engagement, trigger, and expectation from an internal, external, tangible, and intangible perspective proposes a coherent design process that moves from motivation to bridge to interaction to innovate. This approach provides a design framework, expands design's role in fostering social relationships, and enhances practical knowledge of design as a mediator for emotional design concepts. In conclusion, the article provides concrete recommendations for future emotional design practices.

This study offers a more specific exploration of the ideation process and design outcomes. However, it is important to acknowledge the limitations of the research. Firstly, the framework presented was based on limited examples and design principles. Therefore, it may need to fully capture the breadth and depth of design possibilities for empowering social connections. Secondly, the suggested

framework has not been tested in the field through design projects, and its effectiveness in real-world scenarios is yet to be evaluated. Future research should address these limitations by integrating the framework into design projects and assessing the impact of design interventions in the field. Third, the participants and cases in this study have a shared cultural background, which helps us better understand emotional experiences within a consistent cultural context. However, to gain insight into how cultural differences impact the experience of social emotions among marginalized groups, it would be valuable to extend our investigation to a culturally diverse population in the future.

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